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Andrea et al.

[11] **Patent Number:** 6,061,456[45] **Date of Patent:** *May 9, 2000[54] **NOISE CANCELLATION APPARATUS**[75] Inventors: **Douglas Andrea**, Old Brookville;
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[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **09/089,710**[22] Filed: **Jun. 3, 1998****Related U.S. Application Data**

[62] Division of application No. 08/912,459, Aug. 18, 1997, which is a division of application No. 08/485,047, Jun. 7, 1995, Pat. No. 5,732,143, which is a continuation-in-part of application No. 08/339,126, Nov. 14, 1994, Pat. No. 5,673,325, which is a continuation-in-part of application No. 07/968,180, Oct. 29, 1992, Pat. No. 5,381,473.

[51] Int. Cl.⁷ **G10K 11/16**[52] U.S. Cl. **381/71.6; 381/71.13; 381/71.7**[58] Field of Search **381/71.6, 71.13, 381/72, 94.7, 71.7, 93, 74, 372, 386**[56] **References Cited****U.S. PATENT DOCUMENTS**Re. 34,236 4/1993 Taylor .
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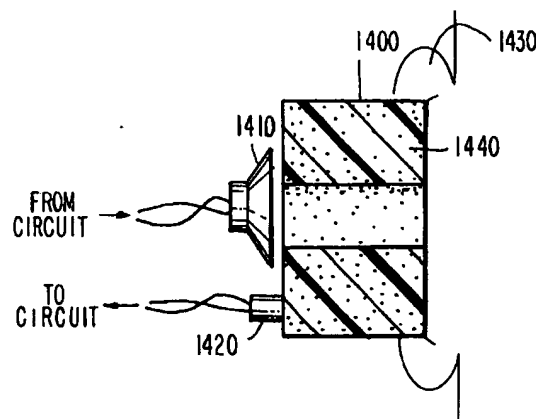
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Primary Examiner—Vivian Chang*Attorney, Agent, or Firm*—Frommer Lawrence & Haug, LLP; Thomas J. Kowalski[57] **ABSTRACT**

Disclosed is a transducer for use in a noise cancellation apparatus for reducing background noise. The transducer includes a housing having first microphone means for receiving a first acoustic sound composed of speech originating from an operator operating the apparatus and background noise, and for converting the first acoustic sound to a first signal, and second microphone means arranged at a predetermined angle ϕ in close proximity with respect to the first microphone means for receiving a second acoustic sound composed of substantially the background noise and for converting the second acoustic sound to a second signal. The first and second microphones are connected to a differential amplifier means of the noise cancellation apparatus so as to obtain a signal representing substantially speech. The amplifier means is for receiving acoustic sounds from each microphone and has a first terminal and a second terminal, wherein the second terminal is grounded. The transducer further includes a transistor means for receiving and amplifying an AC signal representative of the audio input from each microphone; and means for filtering the amplified AC signal from the DC signal, so that the DC signal powers the amplifier means. Also disclosed is a method for calibrating an active noise reduction apparatus including a housing having a speaker to produce an acoustic anti-noise signal in the housing, a microphone to detect an external noise signal, and an amplitude adjustment means to calibrate the acoustic anti-noise signal to create a quiet zone in the housing for operation with an independent electrical assembly, wherein the apparatus is calibrated separately from the electrical assembly. The method includes the steps of: inputting the external noise signal received by the microphone to produce an anti-noise signal; transmitting to the speaker the anti-noise signal having an equal gain and opposite phase response to the external noise signal detected by the microphone; and balancing the gain and phase response of the anti-noise signal by the amplitude adjustment means located in the noise reduction apparatus to match the gain and phase response of the external noise signal to yield a theoretical zero in the quiet zone.

23 Claims, 30 Drawing Sheets

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